Ontario Geological Survey

Northern Ontario
Engineering Geology Terrain Study 81

RIDOUT AREA

(NTS 41O/NE)

District of Sudbury

Compliments of
ONTARIO
MINISTRY OF NORTHERN DEVELOPMENT
AND MINES
Not for resale

by
M.A. Roed and D.R. Hallett

1979

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MAP
(accompanying report)

Map 5015 (coloured) – Northern Ontario Engineering Geology Terrain Study, Data Base Map, Ridout (NTS 41O/NE). Scale 1:100 000.

Northern Ontario

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RIDOUT AREA

(NTS 41O/NE)

District of Sudbury

by

M. A. Roed[1] and D. R. Hallett[2]

1.0 INTRODUCTION:

This report contains an inventory of regional engineering terrain conditions in the Ridout area, District of Sudbury. It forms part of a series of publications which provide similar terrain data for some 370 000 km^2 of northern Ontario.

The area, which covers NTS block 41O/NE, lies between Latitudes 47°30′N and 48°00′N and Longitudes 82°00′W and 83°00′W. Forestry and mineral exploration are the major economic activities in this sparsely populated area, with tourism being an important seasonal activity. Two former gold-silver mines are located in the area, one on Horwood Lake and the other at Jerome on Opeepeesway Lake.

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1.1 TERRAIN MAPPING PROGRAM:

The purpose of the mapping is to provide a guide for engineering and resource planning functions at a level of detail consistent with a scale of 1:100 000. The terrain information is contained on the Data Base Map (OGS Map 5015, accompanying this report).

Interpretation of black and white aerial photographs, at a scale of approximately 1:50 000, was the primary method of obtaining this terrain information. The interpretation includes information from relevant published literature. The main roads in the area were traversed during the summer of 1977 to provide spot checks of the office studies. Thus, the map represents a reconnaissance overview of the engineering conditions of the terrain.

An engineering terrain legend was developed to facilitate the mapping and to provide a common information base for the entire map series. This legend is shown on the accompanying Data Base Map. Further information on the mapping techniques, legend format, and possible uses of the map is available in the "Ontario Engineering Geology Terrain Study Users' Manual" (Gartner, Mollard and Roed, in preparation), a companion publication to this series of maps and reports.

1.2 PREVIOUS WORK:

There have been no previous engineering geology studies undertaken within the area. The surficial deposits have been mapped on a reconnaissance basis by Boissonneau (1965, 1968). Other relevant surficial geology studies can be found in Prest (1969, 1970), Prest *et al.* (1967), Thurston *et al.* (1977), the Ontario Land Inventory (1976), Skinner (1969), and Emmons *et al.* (1929). Regional bedrock geology has been compiled by Thurston *et al.* (1976) and discussed by Thurston *et al.* (1977). Mineral potential has been summarized by Springer (1977).

2.0 GEOLOGIC SETTING:

A discontinuous mantle of Quaternary surficial deposits overlies crystalline bedrock of Precambrian age in the Ridout area. The terrain is characterized by a variety of extensive terrain units, including bedrock, morainal, glaciofluvial, and eolian types.

Distinctive geologic features in this area include the Sultan Scarp (Roed 1979), a possible remnant of the last major glacial stillstand in the area, and extensive outwash plains which have been reworked by eolian processes.

2.1 BEDROCK GEOLOGY:

All of the Ridout area, except for the northern, eastern and southern margins, is underlain by Early Precambrian metavolcanics and metasediments belonging to the Abitibi Belt in the Superior Province of the Canadian Shield. These are surrounded by felsic igneous, metamorphic, and migmatitic rocks on all sides, except in the northwest corner of the area where rocks of the Kapuskasing Structural Zone (mainly arkosic metasediments and metasedimentary gneiss) and Shawmere Anorthosite Complex occur. Major north-northwest-trending faults cut mainly the belt of metavolcanics and metasediments (Thurston *et al.* 1976).

Occurrences of gold, silver, and base metals have been found in the metavolcanics and metasediments; the entire metavolcanic-metasedimentary belt has high or medium potential for these commodities. The surrounding rocks have low or unknown mineral potential (Springer 1977).

2.2 QUATERNARY GEOLOGY:

Northern Ontario was glaciated by continental ice sheets at least four times during the Pleistocene. However, only the deposits of the last glaciation, the Laurentide of Wisconsinan age, are preserved in the Ridout area.

The Keewatin lobe of the Laurentide ice sheet advanced from the northeast at the beginning of the Wisconsinan (approximately 100 000

years ago) and eventually extended as far south as Minnesota (Prest 1970).

By late Wisconsinan time (approximately 11 000 years ago), the ice had receded to the Ridout area and deposited a variety of surficial materials. The glacier may have disappeared completely from the area at this time and then readvanced to the position presently marked by the Sultan Scarp (Roed 1979), or more likely it formed the Sultan Scarp during a halt in its recession. In either event, the Sultan Scarp, located in the southwest corner of the area, is clearly recognized as an ice-contact slope and represents the only major stillstand of this ice sheet in the map-area. The scarp is bounded on the south by an extensive glacio-fluvial outwash plain which represents a substantial outflow of meltwater from a wide front. Much of this meltwater escaped to the west along the valley presently occupied by the Cow River and further west by the Montreal River (Roed and Hallett 1979). During the final phase of this event, drainage in one or more of the meltwater channels must have been blocked, resulting in ponding for a brief time, since raised beaches occur on the surface of the outwash plain south of the Sultan Scarp.

Other important glacial materials that occur throughout the Ridout area include till, deposited directly by the ice, and esker and kame complexes deposited by meltwater in contact with the ice.

Deglaciation of much of the northern part of the map-area occurred by mass disintegration of the ice. Evidence of this is provided by vast tracts of hummocky moraine and pitted outwash plains. Local ponding occurred, but most of the outwash sand exhibits that indicate deposition in slow-moving water. These deposits could generally be interpreted as lacustrine in origin, as in the case of Lake Sultan, described by Boissonneau (1968).

By approximately 9 000 years ago the area was probably ice-free and, for a time, much of the landscape was affected by eolian activity. Modern streams became established and alluvium was deposited. Organic terrain developed in poorly drained depressions. These non-glacial deposits, together with the various glacial deposits, complete the spectrum of Quaternary unconsolidated materials that form a discontinuous mantle over the bedrock.

2.3 PHYSIOGRAPHY:

Local relief in the Ridout map-area is low to moderate, generally less than 60 m. Elevations (above sea level) range from a low of less than 365 m to a high of 550 m close to Ivanhoe Lake on the northern boundary of the area.

3.0 ENGINEERING TERRAIN UNITS:

Engineering terrain units are composed of a combination of various materials (unconsolidated and/or bedrock) which form recognizeable landforms with certain engineering characteristics. Major terrain unit groups, and the engineering significance of each, are discussed in detail. These include rock terrain (RN), moraine (MG,MH), glaciofluvial outwash (GO), eskers (GE), and kames (GK), and eolian deposits (ED). Less significant terrain units include alluvial deposits (AP) and organic terrain (OT). A diagrammatic sketch of a typical terrain setting is given in Figure 1. Table 1 summarizes the characteristics and engineering significance of all major terrain units.

3.1 BEDROCK:

Examples:

$$\frac{\text{RN(tsMG)(pOT)}}{\text{Mu-D(D)(W)}} \qquad \frac{\text{RN(tsMG)}}{\text{Lu-D}} \qquad \frac{\text{RN(tsMG)}}{\text{Lu-D}}$$

Bedrock terrain, which occurs in the northern and southeastern portions of the map-area, constitutes ground that is underlain mainly by bedrock, either at surface or within 1 to 2 m of the surface. There is very little overburden in this unit apart from patches of ground moraine (MG) and some organic terrain (OT) in poorly drained depressions. Small eskers, crevasse fillings, and drumlins also occur. Most of the bedrock terrain is of low (L) to moderate (M) relief and is knobby (n) to undulating (u) in character. Drainage is generally good (D) except in organic depressions.

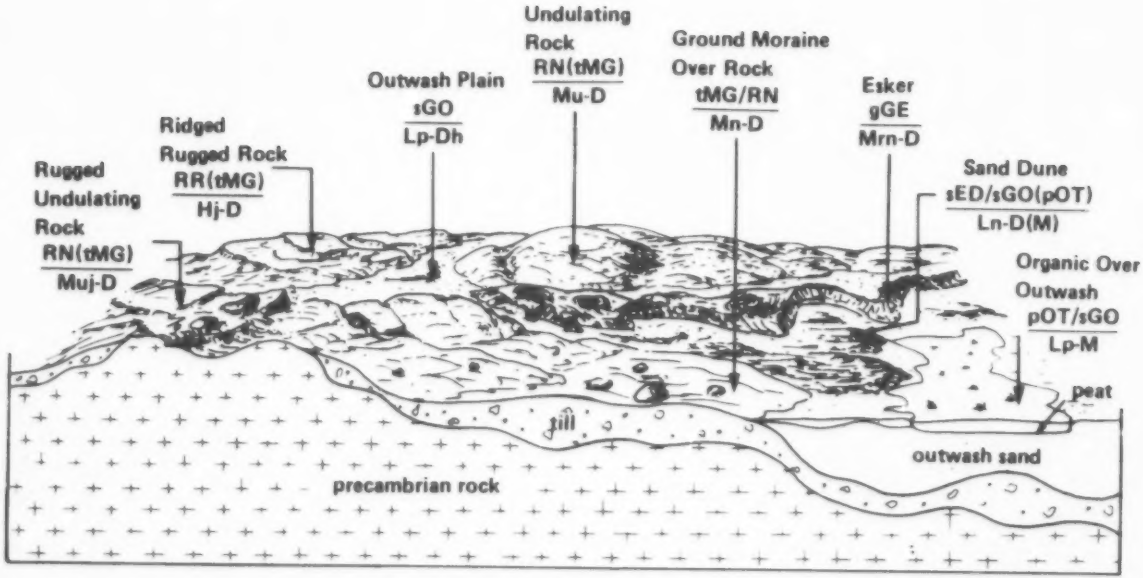

FIGURE 1 – DIAGRAMMATIC SKETCH SHOWING TYPICAL TERRAIN TYPES AND THEIR REPRESENTATIVE LETTER SYMBOLS.

The principal engineering significance of bedrock terrain is that it is difficult and expensive to excavate. Blasting is required for all subsurface excavations. Extensive cut-and-fill operations are required in rugged terrain for transportation route construction, in order to eliminate extreme horizontal and vertical alignments. Many small sand, gravel, and till deposits scattered throughout the terrain provide adequate material for minor access road construction. However, for major transportation routes, aggregate is often imported from considerable distances at high cost.

Bedrock terrain provides excellent foundation conditions in areas that are unaffected by faults and where fracture or joint density is low. The unit also possesses considerable potential for aggregate obtained in rock quarry operations.

Groundwater potential is generally poor in bedrock terrain, but is usually sufficient for scattered domestic demand. Considerable groundwater production can be expected in fractured localities or in fault zones. Bedrock is unsuitable for waste disposal except where a thick layer (at least 1.5 m) of soil material is present.

3.2 MORAINE:

Examples:

$$\frac{\text{tsMG(RN)(pOT)}}{\text{Lnu-D(D)(W)}} \qquad \frac{\text{tsMG(RN)}}{\text{Mu-D}} \qquad \frac{\text{tsMH(RN)(pOT)}}{\text{Lnu-D(D)(W)}} \qquad \frac{\text{tsMH}}{\text{Mn-D}}$$

Morainal landforms in this map-area are either ground moraine (MG) or hummocky moraine (MH).

Ground moraine (MG) consisting of sandy till (ts) occurs throughout the map-area as a major terrain unit or as a subordinate unit in bedrock terrain. The till varies from 1 m to more than 7 m in thickness and commonly occupies rolling terrain of low (L) to moderate (M) relief with undulating (u) to slightly knobby (n) topographic character. The overall drainage is good (D). Low, rounded, rocky hills (RN) and near-surface bedrock (/R) occur within the ground moraine, as does organic terrain (OT) in poorly drained depressions (W). Patches of glaciofluvial outwash,

TABLE 1 SUMMARY OF TERRAIN UNIT CHARACTERISTICS AND ENGINEERING SIGNIFICANCE.

Terrain Unit	Principal Materials	Topography / Drainage	Workability as Construction Material / Permeability	Shearing Strength / Bearing Value	Compaction / Compressibility
Rock Terrain (R)	rock	irregular / dry	not applicable / medium (fracture)	excellent / excellent	not applicable / not applicable
Hummocky Moraine (MH)	till, sand boulders	hummocky / dry	good / medium	good / good	good / low
Ground Moraine (MG)	till, sand boulders	knobby / dry	good / medium	good / good	good / low
Eskers (GE) Kame (GK)	sand gravel	kettled & ridged / dry	excellent / high	excellent / excellent	excellent / low
Outwash (GO) Delta (GD)	sand, gravel	hummocky-planar / dry	excellent / high	excellent / excellent	excellent / low
Glaciolacustrine Plain (LP)	clay, silt fine sand	planar / dry	poor / low	fair / fair	poor / high
Glaciolacustrine Beach (LB)	sand	planar / dry	good / high	good / good	good / low
Alluvium (AP)	sand, silt clay	channelled / mixed	fair / medium	good / poor	fair / medium
Eolian (ED)	sand	ridged, hummocky / dry	fair / high	good / good	good / low
Colluvium Soil (CW,CS)	clay, silt	sloped / mixed	poor / low	poor / poor	poor / high
Colluvium Talus (CT)	rubble	sloped / dry	poor / high	good / poor	poor / low
Organic (OT)	peat	planar / wet	poor / medium	poor / poor	poor / high

Notes:
1. The rating above or below the bar refers to the characteristic or use above or below the bar, respectively, in the column heading.
2. Permeability, compressibility, and frost susceptibility are rated as low, medium, or high; all other characteristics and uses are rated as poor, fair, good, or excellent.

Slope Stability / Frost Susceptibility	Aggregate Supply / Foundations	Highway Subgrade / Route Location	Hydro Easements / Pipeline Routes	Septic Tank Suitability / Solid Waste Landfill	Domestic Groundwater Potential / Large Groundwater Supplies
good (some talus) / not applicable	not applicable / excellent	poor / fair	fair / poor	poor / poor	good / poor
good / low	fair / good	good / good	good / good	excellent / excellent	excellent / good
good / low	fair / good	good / good	fair / fair	excellent / good	good / fair
excellent / low	excellent / excellent	excellent / excellent	good / good	poor / poor	excellent / excellent
excellent / low	excellent / excellent	excellent / excellent	excellent / excellent	poor / poor	excellent / excellent
poor / high	poor / fair	poor / good	good / good	fair / fair	fair / poor
excellent / low	good / good	good / good	good / good	poor / poor	good / poor
fair / medium	poor / poor	poor / poor	poor / poor	poor / poor	good / fair
good / low	poor / good	fair / good	good / good	fair / poor	good / fair
poor / high	poor / poor	poor / poor	poor / poor	poor / poor	fair / poor
good / low	poor / poor	poor / poor	poor / poor	poor / poor	poor / poor
poor / high	poor / poor	poor / poor	poor / poor	poor / poor	poor / poor

3. This is a generalized table intended for use in a number of reports; therefore, all terrain units dealt with in the table will not necessarily appear in each report.

eskers, kames, and hummocky moraine are also associated with the ground moraine. Geological contacts with these units are normally abrupt, except in the case of hummocky moraine and rock terrain where the contacts are often gradational.

Hummocky moraine (MH) also consists of sandy till (ts) and occurs extensively throughout the map-area. The thickness of the till is much more variable than in ground moraine and may be as much as 30 m in some localities. Although till (t) is the principal material, stratified sand (s) and gravel (g), pockets of silt (m), and local concentrations of boulders (b) occur in places. Outwash, eskers, kames, crevasse fillings, rock knobs, and organic deposits are commonly associated with the hummocky moraine. Local relief is generally less than 20 m and the character of the surface is knobby (n), undulating (u), and sometimes kettled (k). Drainage is good (D) except in closed depressions between knobs of till and along poorly developed seepage paths.

Large boulders, patches of poorly drained ground, and the possibility of near-surface bedrock are the principal engineering difficulties that may be encountered in the ground moraine unit. Generally, however, ground moraine poses few serious construction problems and is superior to bedrock terrain for route construction because grades are lower and the necessity of rock blasting is less probable. Pockets of granular material occur, and the till itself is amenable to beneficiation in some localities. Foundation conditions are generally good in till terrain. Groundwater potential is fair where the till unit attains an adequate thickness. Where the till is at least 1.5 m thick, it is suitable for septic system installation.

The engineering significance of the hummocky moraine is substantial. The texture of the till makes the unit suitable for use in the large earth embankments required for roads and dams. Also, the chance of finding a sizeable source of granular material within hummocky moraine is good. Conventional construction techniques can be used throughout, except where local relief is very irregular or where near-surface bedrock is encountered. The till in hummocky moraine is probably the best material in the map-area for attenuation of leachate from municipal land fills and septic drain tile fields. Groundwater potential, although inconsistent, is generally excellent; springs are common at the base of large morainal hills, especially during wet periods of the year.

3.3 GLACIOFLUVIAL:

Examples:

$$\frac{\text{sgGO(sED)(pOT)}}{\text{Lpn-D(D)(M)}} \qquad \frac{\text{sgGO(tsMH)(pOT)}}{\text{Mn-D(D)(W)}} \qquad \frac{\text{sgGO(pOT)}}{\text{Ln-D(W)}}$$

$$\frac{\text{sgGO}}{\text{Lku-D}} \qquad \frac{\text{sgGO}}{\text{Lp-M}} \qquad \frac{\text{sgGE(sED)}}{\text{Mn-D}} \qquad \frac{\text{sgGE(pOT)}}{\text{Ln-D(M)}} \qquad \frac{\text{sgGK}}{\text{Ln-D}}$$

Large tracts of land in the Ridout map-area are underlain by glaciofluvial outwash (GO) composed of sand (s) and gravel (g). Most outwash occurs in the form of undulating (u) to knobby (n) plains (p) of low relief (L) that are sometimes dissected (d), kettled (k), and pitted. Often the upper 2 m of the deposit consists of fine- to coarse-grained sand. This is underlain by stratified pebble to cobble gravel which, in places, is probably greater than 5 m thick. Interbedded sand and gravel layers may occur at depth. The maximum thickness of this outwash unit may be in the order of 40 m, especially in the southern part of the map-area (close to the Sultan Scarp); this estimate of thickness is based on the extent of the unit and the fact that rock terrain with relief in this range has been completely covered. Much of the outwash north of the Sultan Scarp occurs in association with hummocky moraine. Other subordinate landforms include eolian sand (sED), eskers, kames, bedrock knobs (RN), and organic peat deposits (pOT) in wet depressions (W).

More than ten major esker complexes have been identified on the Ridout map-area. The eskers occur as southward-trending, continuous or discontinuous, sinuous, hummocky to rolling ridges of sand and gravel flanked by gently rolling outwash plains and hummocky terrain. Local relief on an esker is usually in the order of 10 to 15 m; pits, kettle lakes, and isolated steep-sided knobs are common. Most of the eskers appear to be composed of sand and gravel in more or less equal proportions, but minor till inclusions and an upper mantle of till occur in places. In the esker core and also where the slopes are steep, gravel is usually the dominant constituent. Not all eskers are topographically prominent, since some have been buried by more recent deposits.

Kames consist of irregular groupings of hills composed of sand, gravel, and till. These landforms differ from eskers in that they are not ridge-like and the internal composition is more heterogeneous and variable.

Otherwise they are similar to eskers. A notable kame and esker complex occurs northeast of Rush Lake in the northeastern part of the map-area.

Eskers and kames are generally well drained, but do include minor patches of poorly drained organic terrain in local depressions. Buried eskers are well drained on the surface, but commonly have a high water table.

The engineering significance of glaciofluvial outwash, eskers, and kames is related to the excellent characteristics of the materials with respect to use in construction. Potential reserves of aggregate are extremely high throughout most of the area. Transportation routes, pipelines, and air strips are easily constructed on the flat outwash plains. Most existing transportation routes in the map-area have taken advantage of this fact. Eskers also have potential as transportation routes, although the sinuous form and some steep topography are disadvantages. Foundation and general construction conditions are excellent in glaciofluvial terrain. Groundwater potential is excellent where the deposits are thick and/or where the water table is high. Glaciofluvial deposits are not suitable for waste disposal, since the materials are permeable and the potential for pollution is high.

3.4 EOLIAN:

Examples:

$$\frac{sED}{Lp\text{-}D} \qquad \frac{sED(sGO)(pOT)}{Lnp\text{-}D(D)(W)} \qquad \frac{sED(pOT)}{Lp\text{-}D(M)} \qquad \frac{sED(tsMH)(pOT)}{Lu\text{-}D(D)(W)}$$

Eolian deposits (ED) of fine sand (s) occur extensively in the central portion of the map-area. The wind-blown deposits are derived mainly from glaciofluvial sand and occur as U-shaped dunes, small hills, and ridges. The deposits generally form a discontinuous blanket over other terrain units, most often outwash (GO), but also hummocky moraine (MH) and organic deposits (OT). Local relief in dune fields ranges from 2 to 5 m, which is also the approximate thickness of these deposits.

The largest dune field straddles the Woman River in the centre of the map-area. Here, U-shaped dunes are all stabilized by vegetation and most are oriented in a southeasterly direction, indicating a prevailing northwest wind at the time of dune formation (assuming a parabolic origin). Extensive dunes also occur to the south of the Sultan Scarp in Wakami Township. Blanket sand is up to 1 m thick and occurs as a discontinuous mantle in dune fields and on parts of adjacent terrain units. Much of the eolian sand shown on the outwash deposit south of the Sultan Scarp is blanket sand. Drainage in the eolian unit varies from good to mixed (D-M) with a high water table (h) in places, especially between some dunes.

Access roads are constructed very easily in eolian terrain, but the erosion potential is high once the protective vegetation cover has been removed. A high water table may limit excavation in places, and slumping and piping can occur. Driven well points will supply enough water for domestic use in eolian deposits below the water table. The pollution potential is high.

3.5 ALLUVIAL:

Examples:

$$\frac{sAP}{Lp\text{-}M} \qquad \frac{sAP(pOT)}{Lp\text{-}D(M)}$$

Alluvial plains (AP) occur along most river channels, but many are too small to map at the scale of 1:100 000. The sandy alluvial plain along the Woman River is the largest in the area and has been mapped. Silt (m) and peat (p) are also common in alluvium. Relief is low (L) and drainage is dry (D) to mixed (M).

Foundation conditions are generally poor in alluvial terrain, since materials are fine grained and water-saturated. Structures built on alluvial plains will be subject to flooding and would require suitable protection. Erosion potential and slope instability are high along stream banks. Groundwater potential is good in gravelly materials and poor in fine-grained materials. Alluvium is not suitable for waste disposal because of periodic flooding and the potential for pollution.

3.6 ORGANIC:

Examples:

$$\frac{\text{pOT}}{\text{Lp-W}} \qquad \frac{\text{pOT(sGO)}}{\text{Lp-M}} \qquad \frac{\text{pOT(sED)}}{\text{Lp-M(D)}}$$

Organic terrain (OT), composed primarily of peat (p) with some silt (m) and sand (s), occurs throughout the map-area in isolated poorly drained (W) depressions within other terrain units. Large deposits occur (1) in several places south of Opeepeesway Lake in the southern part of the area, (2) in Heenan Township in the central part of the area, and (3) north of the Wakami River in the western part of the area.

Construction is difficult and expensive in organic terrain due to the poor drainage conditions and the low strength, low bearing capacity, high compressibility, and extremely high frost susceptibility of the soil materials. Groundwater in organic deposits is generally of poor quality and unsuitable for drinking. Septic drain tile fields should not be placed in organic terrain.

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